



Railroad Industry Overview

**U.S. EPA Region 5 “Tools & Incentives for Green Diesel Technology”
Chicago, Illinois ~ September 6, 2006**

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Union Pacific Railroad

- ➔ Operates 32,000 miles of track in 23 states
- ➔ Largest RR in the U.S., with 50,000 employees (~4,000 in Illinois) ... IL's 1st railroad (since Oct. 24, 1848)
- ➔ 8,000 locomotives (6,500 road & 1,500 switch/local)
 - ✦ ~50% of loco. fleet is EPA emissions certified (since 2000) ... “financial turnover” of fleet is typically 25-30 years
 - ✦ ~2,500 new EPA certified locomotives acquired since 2000 (EPA Tier 0 2000-01, Tier 1 2002-04 and Tier 2 2005-06)
 - ✦ Idle reduction equipment on ~2,700 units (factory-equipped on delivery for past several years, plus retrofits)
- ➔ UP is the rail industry leader in identifying, researching & using (acquiring) new locomotive emissions-reduction technologies



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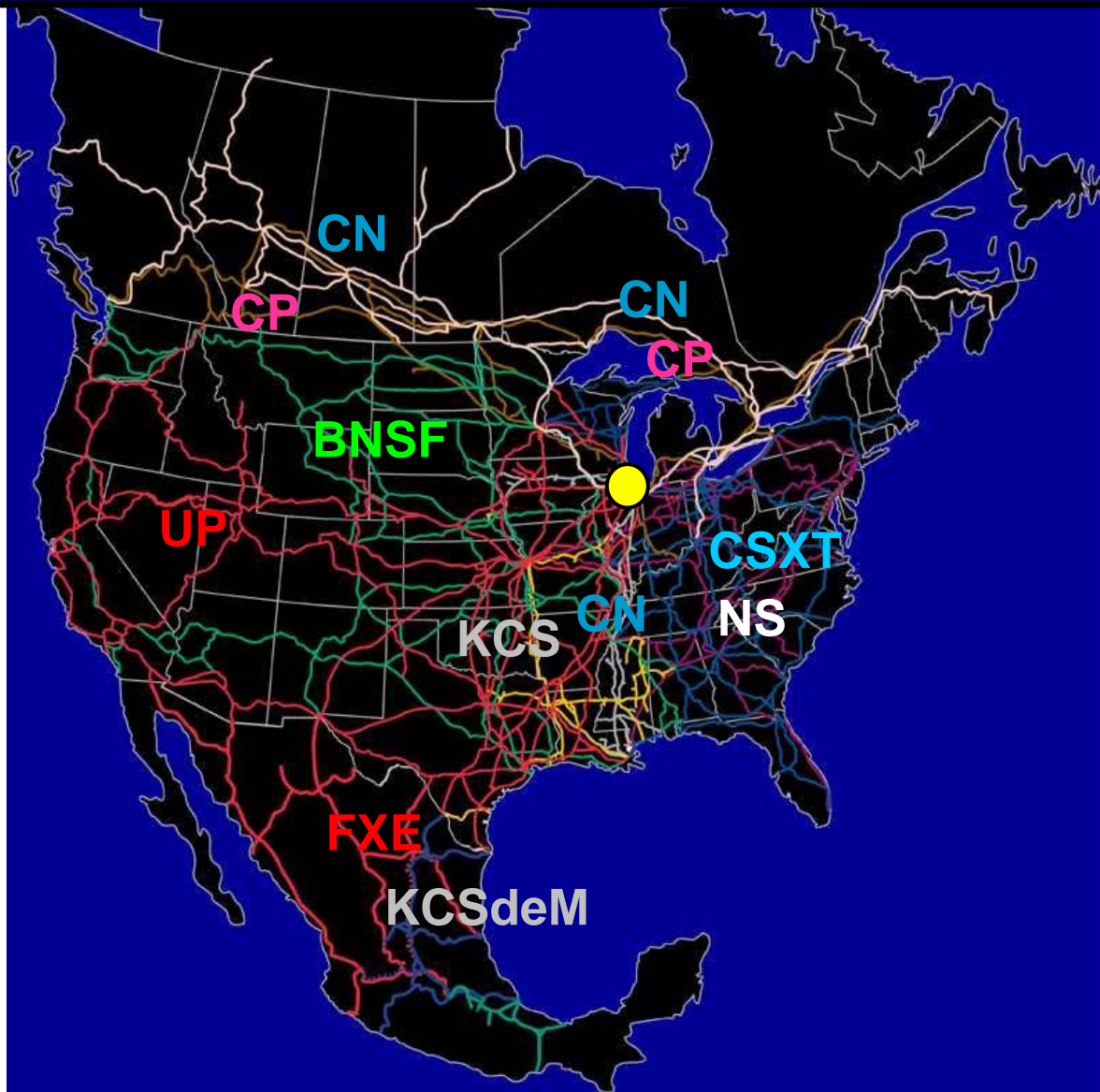
Rail: environmentally friendly freight

- ➡ **All transportation modes have distinguishing and differentiating characteristics**
- ➡ **Rail is 2-to-4 times more fuel efficient than trucks based on gallons of fuel consumed per ton-mile**
- ➡ **Rail produces 1/3rd to 1/2 the exhaust emissions compared to trucks based on mass emissions per ton-mile**
- ➡ **1 double stack container train = up-to-280
18-wheelers**



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N. American rail network

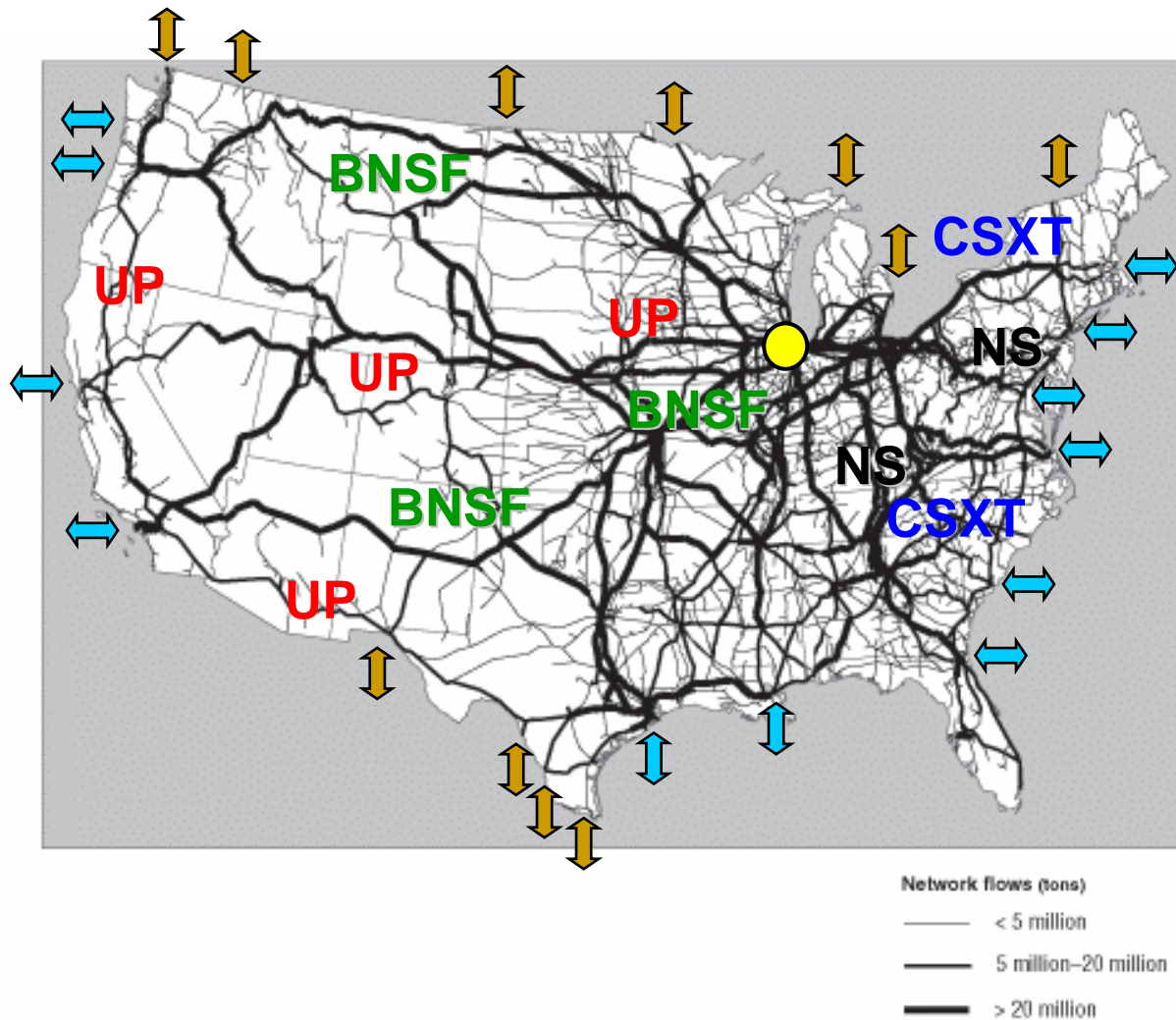


- 7 Class I RRs (5 US & 2 Canadian)
- Regional & short line RRs
- Interchangeability of equipment (except for route-specific extra-high double stack cars)
- 21,000 locos. & 1,300,000+ cars
- 1 common fueling infrastructure



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U.S. primary rail freight traffic flow



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U.S. intermodal rail traffic flow



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“Run thru” trains & locomotives

- ➡ **Key part of rail industry operations & vitality**
- ➡ **“Road” locomotives frequently operate over “other” railroads for 3-months or more, usage is equalized using “HP-hours”**



UP train with power from CN (Canada), UP, TFM (Mexico) & leasing company



BNSF train with power from NS, BNSF & UP



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U.S. locomotive refueling network

- ➡ For BNSF, CSXT, NS & UP (“Big 4” US roads) ...
- ➡ 135 locations with “fixed” fueling nozzles
 - ⚡ designated refueling “pads” with permanent nozzles
 - ⚡ fuel is delivered to storage tanks by highway truck, barge or pipeline ... then distributed to fixed nozzles
- ➡ 302 locations “direct truck to locomotive”
 - ⚡ locomotives are refueled at non-fixed locations (inside RR yards and/or at mainline locations not in yards)
- ➡ 437 total locations



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Chicago Terminal Area

Not To Scale
Not All Tracks Shown

BNSF	IC
BOCT	IHB
BRC	METRA
CN (GTW)	NS
CP	UP
CR	WC
CSX	OTHER RR

METRA Operations as
Tenant Shown on UP Only

EJ&E

BNSF

BNSF
(UP)

NS

CN

IHB

UP

NS

CN

CSXT



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Major
classification
("hump" yard)

Major intermodal
yard

Other yards are
not specifically
denoted

Road v Switching locomotives

➡ Road units typically 3000-4000-4400 HP

- ⚡ EMD and GE, all turbocharged
- ⚡ EPA Tier 0 (2000-01), Tier 1 (2002-04) & Tier 2 (2005+)
- ⚡ Are not geographically based or “home shopped”

➡ Switchers typically 1500-2000 HP

- ⚡ Most are EMD non-turbocharged, most built pre-1980s
- ⚡ New ultra-low emitting genset & hybrid units using EPA offroad diesel engines ... CARB-designated as “Ultra-Low Emitting Locomotives” ... new emerging marketplace
- ⚡ *Switchers tend to be “clustered” in certain areas but can still be relocated within a region based on demand*

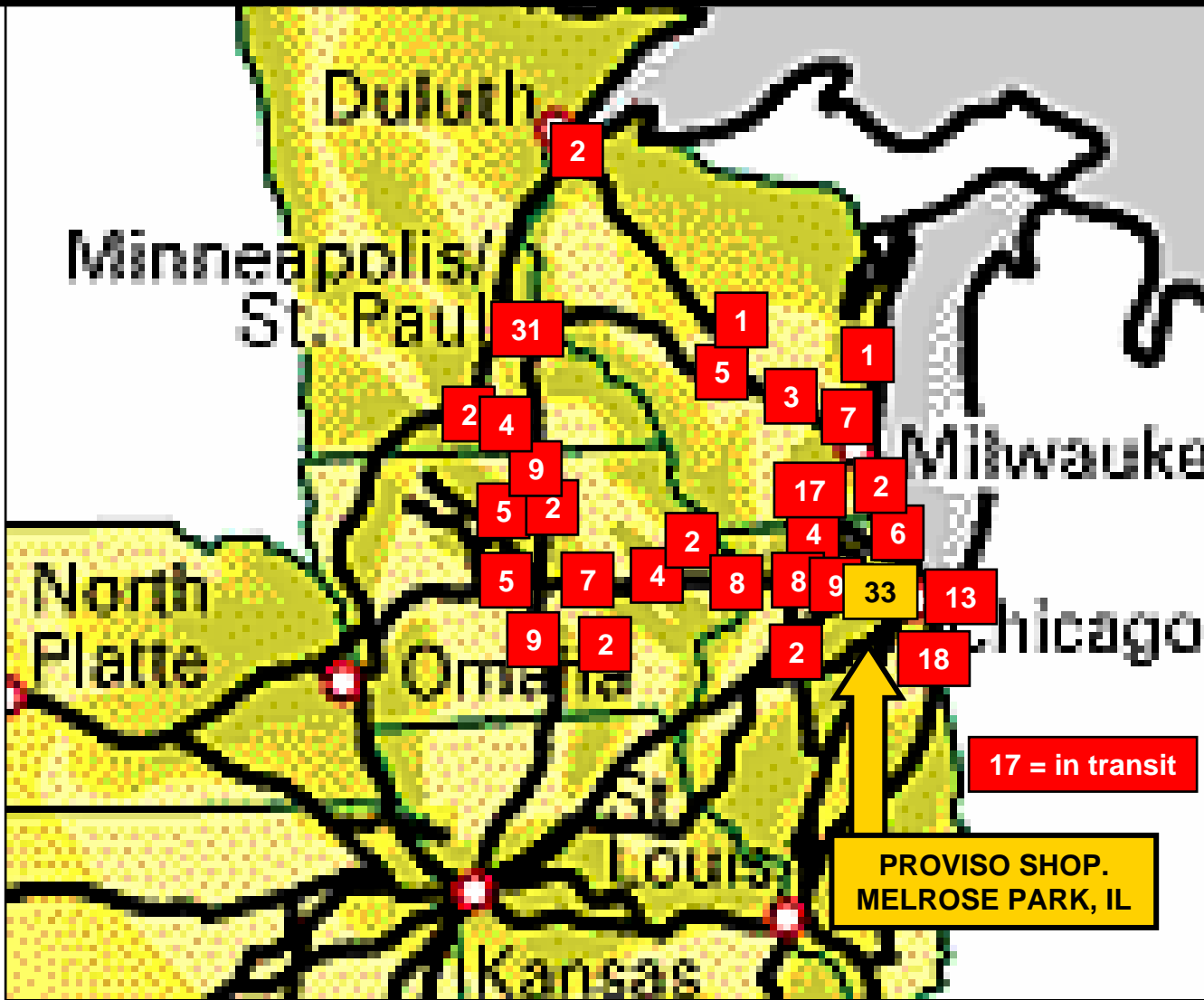
➡ *Example: Melrose Park, IL v Kenosha, WI*

➡ *Example: Canal St.-Chicago v Clinton, IA*



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“Chicago” based UP switchers



UP has approximately 235 low-HP switcher units in the upper midwest, maintained by Proviso Shop in Melrose Park, IL.

***These units are
reassigned
(in IL-WI-MN-IA) as
needed to protect
switching
assignments.***



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Diesel engine marketplace

- ➔ Estimated 2006 North American new locomotive sales will likely be ~1,000 units of all kinds
 - ✦ 4300-4400 HP road freight & a small number of semi-custom design passenger units
 - ✦ <100 new low-emissions switchers (most with truck-derivative off-road engines)
- ➔ By comparison, the “Big 6” diesel engine builders will likely produce in 2006 an estimated ~320,000 diesel engines for Class 8 trucks (>33,000 pounds GVW)
 - ✦ for all new (~66%) and repowered (~34%) Class 8 trucks
- ➔ **Locomotive:truck = 1:320**



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N. American locomotive industry

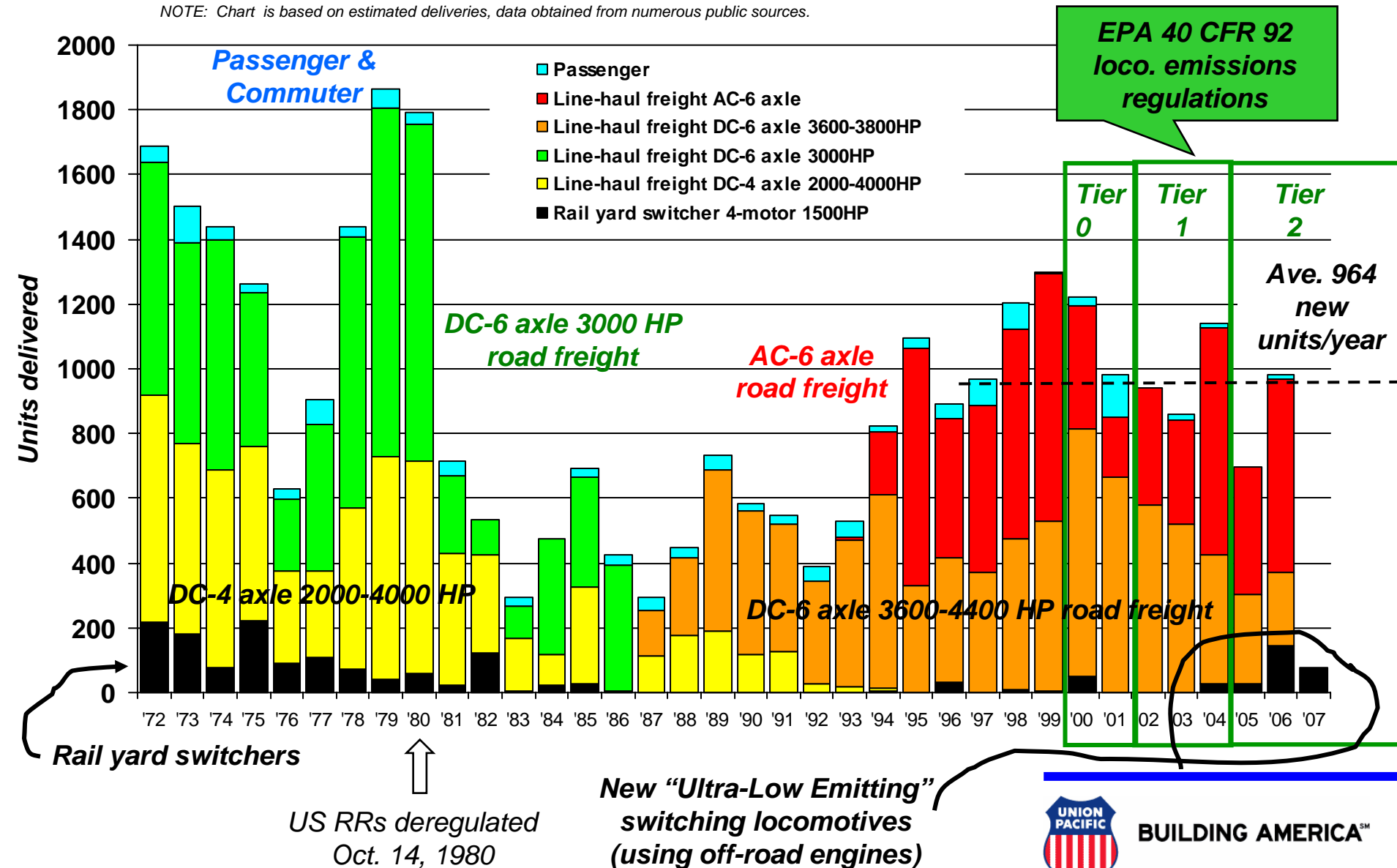
- ➡ **Electro-Motive Diesel, Inc., LaGrange IL**
 - ⚡ 4300 HP road freight units, export designs
- ➡ **GE Transportation Systems, Erie PA**
 - ⚡ 4400 HP road freight units, export designs
- ➡ **MotivePower Industries, Boise ID**
 - ⚡ Remanufactured low-medium HP freight, new passenger units
 - ⚡ “New” switching locomotives
- ➡ **National Railway Equipment, Dixmoor IL**
 - ⚡ Genset switchers
- ➡ **Railpower Technologies, Erie PA**
 - ⚡ Hybrid & genset switchers



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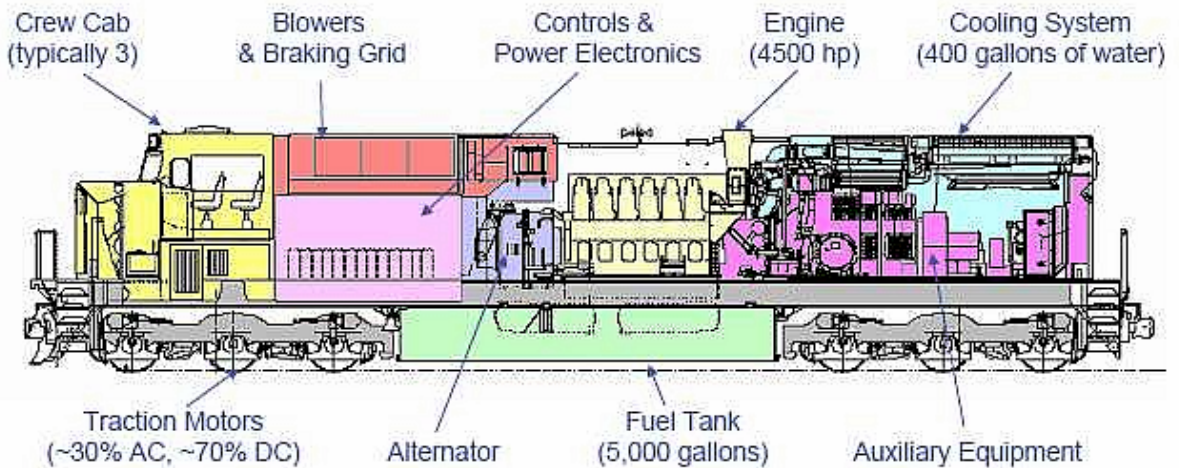
N. American new loco. prod. '72-'06

NOTE: Chart is based on estimated deliveries, data obtained from numerous public sources.



“Locomotives 101”

4400 HP road freight locomotive, EPA Tier 2 (2006) ... UP acquired 316 in '05 & 200 in '06



1500 HP switcher, EPA pre-Tier 0 (1970s)



2000 HP diesel-battery “Green Goat”™ hybrid, “ULEL” << EPA Tier 2 ... UP acquired 11 in '05 & 10 in '06



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Genset units: EPA offroad powered



(3) 700 HP EPA offroad Tier 3 certified diesel generator sets (“gensets”) replace ...

- Inline-6 19L (193 in.³/cylinder), 1800 RPM
- Auto engine stop-start + antifreeze
- Truck-diesel derivative



(1) 2000 HP conventional EPA pre-Tier 0 diesel switcher locomotive engine

- V-16 (645 in.³/cylinder), 900 RPM



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UP-funded all-diesel genset switcher, “ULEL” << EPA Tier 2 ... *UP prototype at Melrose Park, IL in Dec. 2005*

(60) 2100 HP 3-engine units now being built for Los Angeles basin



(98) similar under TERP funding for Texas



1400 HP 2-engine prototype

80-90% reduction in NOx and particulates (and -40% fuel) compared to conventional switchers

61 genset units will eliminate 9% of all loco. emissions in LA basin



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Technologies are market driven

- ➡ Engine and emissions technologies, and technical improvements, “follow the market”:
- ➡ 1 ... Automotive (~ 90-300 HP/engine)
- ➡ 2 ... Truck (~ 250-600 HP/engine)
- ➡ 3 ... Off-road (gensets, construction, ag, small marine)
- ➡ 4 ... Railroad/Locomotive (4000-4400 HP/engine)
- ➡ 5 ... ultra-large Marine (10,000 - 100,000 HP/engine)
- ➡ *Recurrent examples in migration of engine technologies ... exhaust aftertreatment, electronic fuel injection, etc.*



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Alternative RR fuels

- ➔ **Diesel:** *1 common continental refueling infrastructure*
 - ⚡ ~437 U.S. locations where locomotives are refueled
 - ⚡ Single or multiple-linked storage tanks at each location (*i.e., no ability to use multiple/different fuels*)
 - ⚡ #2 (EPA) diesel fuel oil (*consistent requirements for cetane level, climate-specific cloud point in winter, etc.*)
 - ⚡ Road & switch units refueled from same sources
- ➔ **LNG:** -40% operating range penalty vis a vis diesel
 - ⚡ Lower energy density, and lack of RR LNG infrastructure
- ➔ **Biodiesel:** typically doesn't reduce loco. emissions
 - ⚡ Limited testing, no change in PM, and a slight increase in NOx (*... most testing done in small-bore truck diesels*)



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Locomotive aftertreatment

- ➡ Likely necessitated by EPA locomotive Tier 3 reg. 2011+
- ➡ Very limited European experience on locomotives
 - ⚡ DPF: ~100 new German switchers in Switzerland, 6 retrofits
 - ⚡ Oxicats: none in Europe
 - ⚡ Urea-based SCR: none in Europe
- ➡ Initial US R&D activity now underway
 - ⚡ DPF: 1st retrofitted UP EMD *switcher* for Oakland, Oct. '06
 - ⚡ Oxicat: 1st retrofitted UP EMD *road* unit funded by EPA Ann Arbor, for Los Angeles basin, Oct. '06
 - ⚡ OEMs investigating DPF and urea-SCR for production road locomotives to meet likely EPA limits



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Simple “upsizing” of aftertreatment

- ➡ Truck v locomotive diesel engines ... *vastly different*
 - ⚡ Small-bore/high-speed v large-bore/medium-speed, medium-to-high v low-to-medium exhaust temperatures
 - ⚡ Truck engines tend toward lower NOx levels (faster RPM)
- ➡ Acceptable technology transfer always requires extensive “application R&D”
 - ⚡ “Hard lesson” from simplistic “upsizing” of electronic fuel injection (EFI) from truck diesels to locomotive diesels in 1990s ... leaks, cavitation, etc.
 - ⚡ RRs cannot sacrifice loco. reliability & availability to faulty R&D
 - ⚡ ~\$75MM federal funding of truck emissions R&D multi-year, ~\$0 for locomotives (... “the locomotive market is too small” ...)



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UP, AAR, U.S. EPA, et al

- ➡ Extensive discussions with **EPA-WashDC** and **EPA-Ann Arbor** (rule making staff) for 15+ years
- ➡ UP has been involved with **EPA Region 9** (West Coast Diesel Collaborative) for 2 years
 - ⚡ limited funding of idle reduction kits in Roseville, CA yard, and technical oversight/commentary on WCDC proposals
- ➡ UP has been monitoring/communicating with **EPA Region 1** (Northeast Diesel Collaborative)
 - ⚡ application of oxidation catalyst to a Boston commuter loco.
- ➡ UP now involved here with **EPA Region 5**
- ➡ Many opportunities for streamlined communications, “1 stop information exchanges”



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Questions & Comments



“Engines of Change”SM

at

Union Pacific Railroad